

# Claims

- [c1] 1. A thermal barrier coating system on a surface of a substrate, the thermal barrier coating system comprising:
- a bond coat on the surface of the substrate;
  - an alumina scale on the bond coat;
  - a thermal-sprayed first ceramic layer on the alumina scale, the first ceramic layer consisting essentially of partially stabilized zirconia so as to comprise the tetragonal and cubic phases of zirconia, the first ceramic layer being essentially free of vertical microcracks; and
  - a thermal-sprayed second ceramic layer overlying the first ceramic layer, the second ceramic layer consisting essentially of fully stabilized zirconia so as to consist essentially of the cubic phase of zirconia, the second ceramic layer having vertical microcracks that extend through the thickness of the second ceramic layer, the second ceramic layer being thicker and more erosion resistant than the first ceramic layer.
- [c2] 2. The thermal barrier coating system according to claim 1, wherein the bond coat is an overlay coating.
- [c3] 3. The thermal barrier coating system according to claim

2, wherein the bond coat is an MCrAlX overlay coating.

[c4] 4. The thermal barrier coating system according to claim 1, wherein the first ceramic layer consists of zirconia, at least one stabilizer, and incidental impurities.

[c5] 5. The thermal barrier coating system according to claim 4, wherein the stabilizer is yttria in an amount of about 7 to about 8 weight percent of the first coating layer.

[c6] 6. The thermal barrier coating system according to claim 1, wherein the second ceramic layer consists of zirconia, about 18 to about 20 weight percent of yttria as a stabilizer, and incidental impurities.

[c7] 7. The thermal barrier coating system according to claim 1, wherein the first ceramic layer is an air plasma sprayed layer.

[c8] 8. The thermal barrier coating system according to claim 1, wherein the first and second ceramic layers are plasma sprayed layers.

[c9] 9. The thermal barrier coating system according to claim 1, wherein the first and second ceramic layers have a combined thickness of about 250 to about 2000 micrometers.

[c10] 10. The thermal barrier coating system according to

claim 9, wherein the first ceramic layer has a thickness of about 25 to about 250 micrometers.

[c11] 11. The thermal barrier coating system according to claim 9, wherein the second ceramic layer has a thickness of about 125 to about 2000 micrometers.

[c12] 12. The thermal barrier coating system according to claim 9, wherein the first and second ceramic layers have a combined thickness of at least 500 micrometers.

[c13] 13. The thermal barrier coating system according to claim 1, wherein the first and second layers consist essentially of splats so as to have microstructures characterized by irregular flattened grains.

[c14] 14. The thermal barrier coating system according to claim 1, wherein the substrate is a surface region of a gas turbine engine component.

[c15] 15. The thermal barrier coating system according to claim 14, wherein the gas turbine engine component is a combustor liner.

[c16] 16. The thermal barrier coating system according to claim 14, wherein the gas turbine engine component is a turbine shroud.

[c17] 17. A thermal barrier coating system on a surface of a

gas turbine engine component, the thermal barrier coating system comprising:

- an overlay bond coat on the surface of the substrate;
- an alumina scale on the bond coat;
- a plasma-sprayed first ceramic layer on the alumina scale, the first ceramic layer consisting essentially of zirconia partially stabilized by about 7 to about 8 weight percent yttria so as to comprise the tetragonal and cubic phases of zirconia and so as to have a phase transformation temperature, the first ceramic layer being essentially free of vertical microcracks; and
- a plasma-sprayed second ceramic layer on the first ceramic layer, the second ceramic layer consisting essentially of zirconia stabilized by about 18 to about 20 weight percent yttria so as to consist essentially of the cubic phase of zirconia, the second ceramic layer having vertical microcracks that extend through the thickness of the second ceramic layer;

wherein the first and second ceramic layers have a combined thickness of about 500 to about 2000 micrometers, the first ceramic layer has a thickness of up to about 125 micrometers, and the second ceramic layer is thicker and more erosion resistant than the first ceramic layer.

claim 17, wherein the gas turbine engine component is subjected to an operating temperature at which the first ceramic layer sustains maximum temperatures below the phase transformation temperature thereof and the second ceramic layer sustains maximum temperatures above the phase transformation temperature of the first ceramic layer.

[c19] 19. The thermal barrier coating system according to claim 17, wherein the gas turbine engine component is a combustor liner.

[c20] 20. The thermal barrier coating system according to claim 17, wherein the gas turbine engine component is a turbine shroud.